Florida Department of Transportation
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DEVELOPING SPECIFICATIONS FOR USING RECYCLED ASPHALT PAVEMENT AS BASE, SUBBASE OR GENERAL FILL MATERIALS

PROBLEM STATEMENT

Reclaimed asphalt pavement (RAP) stockpiles in Florida have been growing due to the rehabilitation of the state's roadways. Currently, the major use for RAP is as an aggregate in hot mix asphalt (HMA) production. The application of RAP as a Florida Department of Transportation (FDOT) approved base course, subbase, and subgrade has been hindered due to low reported laboratory Limerock Bearing Ratio (LBR) test results.

OBJECTIVES

Determining the engineering properties of RAP and the effect that storage time at elevated temperatures has on these properties may increase the potential for the use of RAP as a structural fill or as highway construction material. Thus, laboratory investigation was conducted:

- to determine the strength and deformation properties of RAP,
- to evaluate the effects of post milling on these properties, and
- to evaluate the effect of storage time at elevated temperatures on these properties.

A series of tests were performed at 2-month intervals over 12 months at a field site comprised partially of RAP and partially of cemented coquina (control). The objectives of the field-based part of the study were:

- to analyze the performance of RAP at the site over 12 months,
- to determine which tests most accurately reflect the feasibility of RAP as a subgrade, subbase, and base course based on the ease of performance and reliability of results, and
- to develop a set of developmental specifications for using RAP as a base, subbase or subgrade.

FINDINGS AND CONCLUSIONS

The following are among the results of the ***laboratory tests.***

Effects of Post-Milling Processing: The post-milling of RAP with the tubgrinder or hammersmill process yields materials that fall outside of the ranges specified by Talbot and ASTM D 2940-92, "Standard Specification for Graded Aggregate Materials for a Base or Subbase."

Effects of Compaction: RAP compacted using modified Proctor, modified Marshall, vibratory, and static methods did not display classical moisture-density behavior. The dry density was relatively constant at the moisture contents greater than 4%. Samples from all compaction methods had free draining water at moisture contents greater than 10%. There were very slight differences in dry density due to processing. These differences most likely are due to grinding and sample variations. Field compaction of RAP should be conducted using moisture contents from 3% to 7%.

Effects of Temperature: Increasing temperature has a significant effect on most of the triaxial properties of RAP. As the storage temperature increases from 75° F to 100° F, the maximum principal stress at failure, secant modulus and cohesion intercept values of both post-milling processes increased. The RAP samples stored at l25° F had similar behavior to RAP stored at 100° F. The angle of friction for both materials does not vary with an increase in temperature.

Effects of Time: The triaxial properties of RAP are not affected by the duration of storage time. The maximum principal stress at failure, the secant modulus, the angle of friction, and the cohesion intercept remain relatively constant with increased storage time.

Highway Construction Applications: The engineering properties of RAP found in this investigation show that RAP is a suitable material for use as structural fill and for roadway base and subbase applications. RAP could be used as backfill in roadways or as construction material for embankments around pipes and culverts. The RAP potentially could be used in roadway subbase and base applications if it meets appropriate highway construction specifications, such as the Limerock Bearing Ratio.

The following are among the results of the ***field study.***

Constructability: The RAP was successfully installed on high moisture content subsurface soils without any delays or dewatering. The installation procedure was identical to that for installing cemented coquina.

Applications: (1) Base Course: FDOT minimum requirements for a material to be used as a base (LBR=100) were obtained during the cooler temperature testing cycles but could not be sustained during the warmer months, nor were they attained during installation. Therefore, when using field LBR results, RAP is not a feasible base course material. (2) Subbase and Subgrade: RAP achieved field LBR values of 40 by the second testing cycle and maintained a minimum value of 40 for approximately 80% of the subsequent tests. Therefore, when using field LBR results, RAP is a potential subbase or subgrade material.

Testing: Falling weight deflectometer testing proved the most viable alternative to field CBR testing.

Density and Relative Compaction: Density showed minimal correlation to any of the strength parameters measured in the field. Equivalent compaction energy from smooth steel drum vibratory rollers will result in equivalent relative compaction between cemented coquina and RAP.

Temperature: Temperature gradient is greater near the surface and decreases with increasing depth.

Modulus of Elasticity, E_S: The predicted range of field E_S values for RAP was lower than the measured laboratory values.

LBR: RAP achieved a minimum LBR of 40 in *50%* of all tests performed on the 12-inch layer, 71% of the tests performed on the 24-inch layer, and 79% of the tests performed on the 36-inch layer. Once the RAP achieved the FDOT minimum requirement for a subbase (LBR=40), about 20% of the subsequent tests dropped below 40.

Impulse Stiffness Modulus, ISM: The variation in the ISMs with time is similar to the time variations of E_S and the LBR. During the cooler months, the ISM increases, and during the warmer months, the ISM decreases.

RAP vs. Cemented Coquina: Overall, RAP exhibited as high a strength as the cemented coquina; however, the cemented coquina exhibited very poor drainage characteristics, making it unworkable during initial site construction. LBR and ISM data showed that RAP strength did not fluctuate as much as the cemented coquina, due to the effects of moisture. RAP performance varied more than cemented coquina when subjected to varying thermal conditions. The stiffness of RAP decreased when exposed to prolonged ambient air temperatures exceeding 80° F.

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